

WHAT IS CLAIMED IS:

1. An image processing apparatus which multiplexes noise on multilevel image data to embed visible additional information with a noise-multiplexed distribution,

5 comprising:

first noise multiplexing means for multiplexing noise at a first visible intensity;

second noise multiplexing means for multiplexing noise at a second visible intensity different from the first

10 visible intensity;

input means for inputting, as the additional information for a predetermined pixel region unit, information representing which of the first and second visible intensities is used for multiplexing;

15 determination means for determining on the basis of the additional information which of the first and second visible intensities is used for multiplexing in a pixel region of interest in multilevel image data; and

control means for selecting either of said first and  
20 second noise multiplexing means for the pixel region of interest on the basis of a determination result of said determination means, and causing selected noise multiplexing means to multiplex noise.

2. The apparatus according to claim 1, wherein each of  
25 said first and second noise multiplexing means determines an arithmetic bit region subjected to noise multiplexing in the pixel region of interest on the basis of a supplied

visible intensity, and performs reversible logical calculation of noise bit information by a random number for the determined arithmetic bit region, thereby multiplexing noise.

5     3.     The apparatus according to claim 2, wherein the arithmetic bit region is determined by further referring to data of the predetermined pixel region.

4.     The apparatus according to claim 1, wherein each of said first and second noise multiplexing means determines  
10     an arithmetic bit region subjected to noise multiplexing in the pixel region of interest on the basis of data of a region near the pixel region of interest and a supplied visible intensity, and performs reversible logical calculation of noise bit information by a random number for  
15     the determined arithmetic bit region, thereby multiplexing noise.

5.     The apparatus according to claim 1, wherein the predetermined pixel region includes a single pixel.

6.     The apparatus according to claim 1, wherein the  
20     predetermined pixel region includes a pixel block of a predetermined size.

7.     The apparatus according to claim 1, wherein the predetermined pixel region includes a DC component obtained by orthogonal transform in JPEG compression coding.

25     8.     The apparatus according to claim 1, wherein the predetermined pixel region includes a low-frequency-component block obtained by wavelet

transform in JPEG 2000 compression coding.

9. An image processing apparatus which removes visible additional information from multilevel image data in which noise is reversibly embedded to multiplex the visible additional information, comprising:

first noise removal means for removing noise multiplexed at a first visible intensity;

- second noise removal means for removing noise multiplexed at a second visible intensity different from the first visible intensity;

input means for inputting, as the additional information for a predetermined pixel region unit, information representing which of the first and second visible intensities is used for multiplexing;

- determination means for determining on the basis of the additional information which of the first and second visible intensities is used for multiplexing in a pixel region of interest in multilevel image data; and

- control means for selecting either of said first and second noise removal means for the pixel region of interest on the basis of a determination result of said determination means, and removing multiplexed noise.

10. An image processing method of multiplexing noise on multilevel image data to embed visible additional information with a noise-multiplexed distribution, comprising:

a first noise multiplexing step of multiplexing noise

at a first visible intensity;

a second noise multiplexing step of multiplexing noise at a second visible intensity different from the first visible intensity;

5 an input step of inputting, as the additional information for a predetermined pixel region unit, information representing which of the first and second visible intensities is used for multiplexing;

a determination step of determining on the basis of  
10 the additional information which of the first and second visible intensities is used for multiplexing in a pixel region of interest in multilevel image data; and

a control step of selecting either of the first and second noise multiplexing steps for the pixel region of  
15 interest on the basis of a determination result in the determination step, and multiplexing noise.

11. An image processing method of removing visible additional information from multilevel image data in which noise is reversibly embedded to multiplex the visible  
20 additional information, comprising:

a first noise removal step of removing noise multiplexed at a first visible intensity;

a second noise removal step of removing noise multiplexed at a second visible intensity different from  
25 the first visible intensity;

an input step of inputting, as the additional information for a predetermined pixel region unit,

information representing which of the first and second visible intensities is used for multiplexing;

a determination step of determining on the basis of the additional information which of the first and second  
5 visible intensities is used for multiplexing in a pixel region of interest in multilevel image data; and

a control step of selecting either of the first and second noise removal steps for the pixel region of interest on the basis of a determination result in the determination  
10 step, and removing multiplexed noise.

12. A computer program functioning as an image processing apparatus which multiplexes noise on multilevel image data to embed visible additional information with a noise-multiplexed distribution, functioning as:

15 first noise multiplexing means for multiplexing noise at a first visible intensity;

second noise multiplexing means for multiplexing noise at a second visible intensity different from the first visible intensity;

20 input means for inputting, as the additional information for a predetermined pixel region unit, information representing which of the first and second visible intensities is used for multiplexing;

determination means for determining on the basis of  
25 the additional information which of the first and second visible intensities is used for multiplexing in a pixel region of interest in multilevel image data; and

control means for selecting either of said first and second noise multiplexing means for the pixel region of interest on the basis of a determination result of said determination means, and causing selected noise  
5 multiplexing means to multiplex noise.

13. A computer-readable storage medium storing a computer program defined in claim 12.

14. A computer program functioning as an image processing apparatus which removes visible additional information  
10 from multilevel image data in which noise is reversibly embedded to multiplex the visible additional information, functioning as:

first noise removal means for removing noise multiplexed at a first visible intensity;

15 second noise removal means for removing noise multiplexed at a second visible intensity different from the first visible intensity;

input means for inputting, as the additional information for a predetermined pixel region unit,  
20 information representing which of the first and second visible intensities is used for multiplexing;

determination means for determining on the basis of the additional information which of the first and second visible intensities is used for multiplexing in a pixel  
25 region of interest in multilevel image data; and

control means for selecting either of said first and second noise removal means for the pixel region of interest

on the basis of a determination result of said determination means, and removing multiplexed noise.

15. A computer-readable storage medium storing a computer program defined in claim 14.